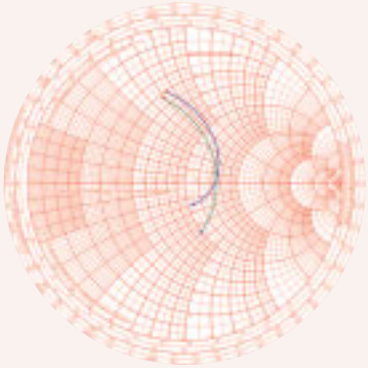
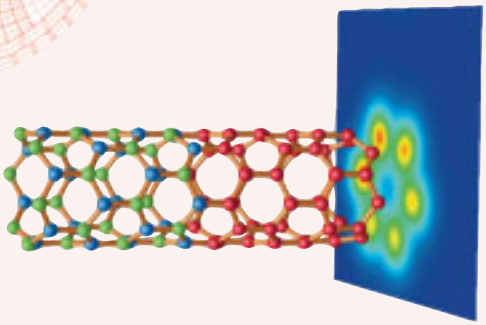
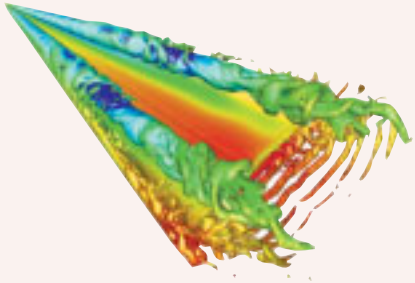
DoD HPC
Modernization Program

Tools for Discovery



2002
Annual Report





Front cover captions (from top to bottom):

Accurate Modeling of Lossy Frequency Selective Surfaces for Real-Time Design by John Meloling, Wendy Massey, and David Hurdsman
Smith chart of boundary admittance using past approximations (green) and more accurate solutions (blue)

Mixed Electromagnetic — Circuit Modeling and Parallelization for Rigorous Characterization of Cosite Interference in Wireless Communication Channels by Costas Sarris
Electric field magnitude iso-surface on a military vehicle staircase model at 50 MHz

Absolute Scalability of Space/Time Domain Decomposition in Computational Structural Dynamics for Virtual Modeling and Testing Applications by R. Kanapady and K. K. Tamma
Solid modeling of keel beam

Novel Electron Emitters and Nanoscale Devices by Jerry Bernholc
Electron distribution near a tip of a BN/C nanotube in a field emitter configuration

Detached-Eddy Simulation of Massively Separated Flows over Aircraft by Kyle Squires, James Forsythe, Scott Morton, Kenneth Wurtzler, William Strang, Robert Tomaro, and Philippe Spalart
Flow over the delta wing at 27° angle of attack. Isosurface of vorticity

For more information about the DoD HPC Modernization Office and the DoD HPC Modernization Program, visit our Web site at http://www.hpcmo.hpc.mil

Department of Defense

High Performance Computing Modernization Program

2002 Annual Report

A Report by the Department of Defense
High Performance Computing Modernization Program Office

July 2003

Message from the Director

The Department of Defense's High Performance Computing Modernization Program entered into its ninth year in 2002, successfully realizing the Congressional and senior Defense leadership vision of creating a pervasive supercomputing environment that the Department's scientists and engineers routinely use as they conduct the research, development, test, and evaluation activities needed to maintain our national defense posture.

We saw several procedural changes take effect in 2002, largely based on applying the lessons learned in previous years. We continued to examine the best means of maximizing our return on investments through benchmarking and differing acquisition strategies. We awarded a major contract, the Defense Research and Engineering Network follow-on contract, and began planning for transition and upgrade. We selected our industry partners to assist us in running the four major shared resource centers. Our Software Applications Support component was transformed through the use of portfolios that span multiple scientific disciplines, and training of the community was expanded with implementation of the Online Knowledge Center.

As the year began, we as a nation were faced with the reality of the war on terrorism. As the year progressed, the ongoing work of the Department's scientists and engineers, using High Performance Computing Modernization Program resources, made a material difference in liberating Afghanistan and strengthening our Homeland Defensive posture. High performance computing environments supported national priority work on thermobaric weapons and unmanned aerial, land-based, and submersible vehicles. Scientists using our resources have addressed chemical and biological threats, including anthrax and chemical detection and decontamination.

This annual report provides the program's users and stakeholders with a concise summary of the state of the program, details our progress in achieving our objectives, and includes a brief discussion of some of the challenges we will address in the years ahead.

Cray J. Henry
Director
High Performance Computing Modernization Program

The HPCMP Management Team

Dr. Larry Davis
Deputy Director

Dr. Robert Peterkin
Chief Scientist

Dr. Leslie Perkins
SAS

Mr. Brad Comes
HPC Centers

Mr. Rodger Johnson
Networking

Ms. Jann Ensweiler
Outreach

Mr. John Blair
Financial

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Section 1

Overview and Analysis

Program Mission

The HPCMP's mission is to deliver world-class commercial, high-end, high performance computational capability to the DoD's science and technology and test and evaluation communities facilitating the rapid application of advanced technology into superior warfighting capabilities.

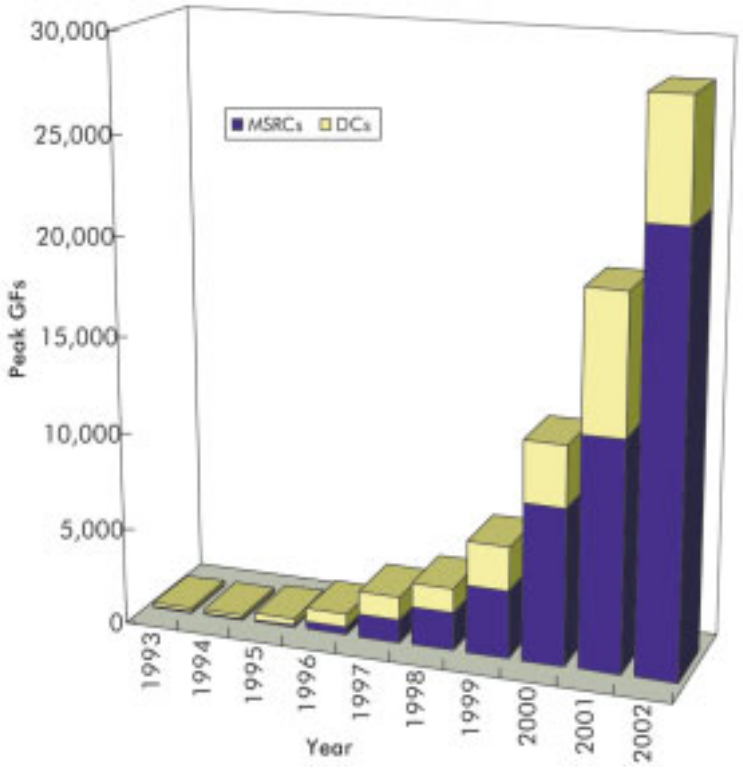
Program Vision

The HPCMP's vision is to provide a pervasive culture among DoD's scientists and engineers where they routinely use advanced computational environments to solve the most demanding problems.

SECTION 1 — OVERVIEW AND ANALYSIS

INTRODUCTION

The Department of Defense's High Performance Computing Modernization Program (HPCMP) provides the Department's scientists and engineers with an extraordinary computational environment to further national defense objectives. In less than ten years, the Program has produced an outstanding computing environment that routinely uses high performance computing resources to solve the Department's most challenging scientific and engineering problems. This, in turn, helps the United States ensure military advantage and warfighting superiority on the 21st century battlefield.



Congressional investment in and support of the HPCMP has caused cultural changes in the fundamental way science and engineering are pursued. In 1993, the Department had just over 180 gigaflops of computational power to support the science and technology community. Through sound management practices, a deliberate user based requirements identification process, appropriate oversight, and an integrated approach, we have expanded those capabilities to over 27,000 gigaflops in 2002. Similarly, basic wide area networking services linking the laboratories over government owned, government operated assets have transformed into a commercial "cloud" providing a secure, high bandwidth capability currently reaching OC-48 on the backbone with the potential for OC-768. The DoD processes for conducting research, development, test, and evaluation have been redesigned to include physics based simulation in support of, or in place of, physical experimentation and test. This change would not have been possible without the hardware, networks, and software provided by the HPCMP, as well as the vigorous training and knowledge transfer the Program has fostered. As connectivity and computational power have improved, projects have gone

from being single Service, single-discipline projects to Joint Service, multi-discipline projects.

The HPCMP is a continuous critical technology insertion program. Our mission is to deliver world-class commercial, high-end, high performance computational capability to the DoD's science and technology and test and evaluation communities facilitating the rapid application of advanced technology into superior warfighting capabilities. Our vision is to create a pervasive culture among DoD's scientists and engineers where they routinely use advanced computational environments to solve the most demanding problems. The emphasis is on leveraging the national trends fostered by existing Federal investments in high performance computing and communications programs, information technology, high performance computing research and development programs, and other related research, development, and test and evaluation efforts.

We are guided by five broad strategic goals to achieve that vision. These goals, and the progress we are making in meeting them, are discussed in detail in Section 2.

The Program consists of three components — HPC Centers, Networking, and Software Applications Support. These components are interdependent, supporting different technology areas, having different contractual relationships, and having different baseline goals. The Director provides overall guidance and sets individual cost, schedule, and performance goals for each project manager. The Program Office staff monitors and evaluates the progress of each element towards meeting the program goals. We evaluate the effectiveness of each program component by measuring actual cost and schedule performance versus planned cost and schedule performance and through the measurement of actual outcomes verses planned outcomes. Periodically, each component undergoes formal review with the Director.

The DoD high performance computers have been used to solve urgent problems associated with conflicts involving the US since the program's inception. For example, in Bosnia, the US Army Corps of Engineers used DoD HPCs to model flooding on the Sava River. This information allowed our forces to establish ground positions out of harms way and showed us where to build transportation routes across the area to maintain mobility. Another example is the rescue of a downed pilot in Kosovo. High performance computing-enabled simulations of Joint Search and Rescue operations allowed the rescuers to practice the scenario before undertaking the mission.

HPCMP Goals

- Provide the best commercially available high-end HPC capability
- Acquire and develop joint-need HPC applications, software tools, and programming environments
- Educate and train DoD's scientists and engineers to effectively use advanced computational environments
- Link users and computers sites via high-capacity networks, facilitating user access and distributed computing environments
- Promote collaborative relationships among the DoD HPC community, the National HPC community and Minority Serving Institutions (MSIs) in network, computer, and computational science

Program Accomplishments

Background

In 2000, the Office of the Under Secretary of Defense (Acquisition, Technology and Logistics) chartered an overarching-integrated product team (O-IPT) to review the overall program and the DoD projects it supports. The O-IPT performed a comprehensive zero-based review on the need for the HPCMP. The results of the O-IPT review were overwhelming showing that high performance computing is essential in developing our future warfighting systems.

House Committee Report 107-298 DoD Appropriations Bill, 2002, reaffirmed the need for High Performance Computing in supporting DoD core functions. Specifically mentioned were: operational weather forecasting, dispersion of airborne contaminants, armor design, design of large aircraft or ship structures, and studies of weapons effects.

In FY 2000, we started to reeingineer our business process for procuring supercomputers like "Technology Insertion-2001 (TI-01)"—to take a more corporate approach to acquisition and to investigate the value of alternative purchasing options for upgrades (which would be made starting in FY 2001).

In FY 2001, the acquisition plan for TI-02 continued this initiative, incorporating lessons learned from TI-01. In this upgrade, we negotiated integration fees in advance with the Major Shared Resource Center (MSRC) integrators and established alternatives, pricing, and performance through a set of benchmarks and two sequential requests for quotes. In FY 2002, a further step in the evolution of the technology insertion process (TI-03) eliminated integrating contractors and the fees resulting from that process. An interagency agreement was established with General Services Administration (GSA) and a joint team established alternatives, pricing, and performance through a set of system benchmarks and two sequential Requests for Quote.

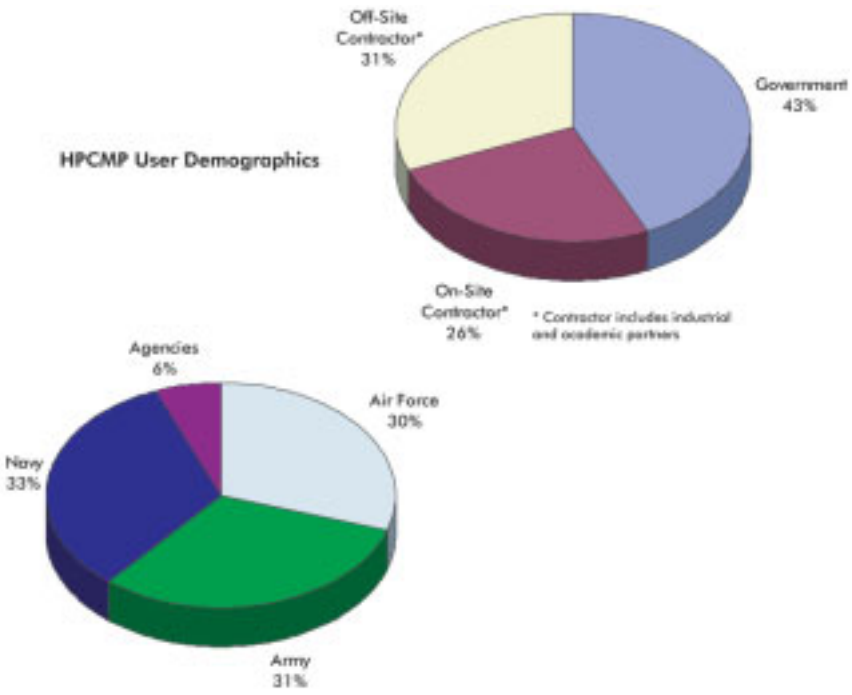
2002 Accomplishments

In 2002, the High Performance Computing Modernization Program had over 4,000 users working on over 600 projects at 100 sites throughout the continental United States, Alaska, and Hawaii. The user base was diverse, including representatives of

each of the Services, several DoD agencies, industrial partners, and academia.

The Program continued to build on the successes of past efforts during 2002. A few highlights include:

- The program sustained existing capability and continued modernizing HPC systems, storage, and scientific visualization capabilities to fulfill a significant portion of the projected research and development, and laboratory and center HPC requirements. Generally the program replaces 25% of the HPC equipment annually.



- Network services provided under the Defense Research and Engineering Network (DREN) Intersite Services Contract (DISC) began to transition to the follow-on service provider. Operation of security systems and enhancements continued. Collaborative work continued with the Federal networking community and standards associations to ensure DREN remains compatible with future technology change. FY 2002 funding reductions delayed implementation of Virtual Private Network technology.

- Within Software Applications Support (SAS), development efforts in the Common HPC Software Support Initiative (CHSSI) program continued to mature as some CHSSI projects were completed and others began. The Programming Environment and Training (PET) effort provided computational and computer science support to the DoD HPC user community through interaction and collaborative projects with academic and industrial partners. A program was established to develop technologies and methodologies to protect and limit end-use of high performance computing applications software while minimizing the burden on authorized end-users. FY 2002 funding reductions delayed some software development and protection efforts.

Other Collaborative Accomplishments

Members of the HPCMP community have sought to leverage the knowledge and experience of other federal agencies and activities

to foster communications and to build strong and viable supercomputing environments at the national level. Using interagency agreements and Memoranda of Understanding, the High Performance Computing Modernization Program Office (HPCMPO) staff has worked collaboratively with several of the foremost federal supercomputing agencies, including the National Aeronautics and Space Administration, the National Science Foundation, the Department of Energy's (DOE) laboratories, and Federally Funded Research and Development Centers such as MIT's Lincoln Laboratory and the MITRE Corporation. The HPCMP community participates in several working groups that focus on supercomputing issues and furthers US supercomputing interests, such as the National Coordination Office's High End Computing and Computation Working Group, the Large Scale Networking Coordinating Group's Joint Engineering Team, and the work done by several federal agencies on the National Security Agency led "Operational Requirements Working Group Report on High Performance Computing Requirements for the National Security Community".

The HPCMP has been and continues to be involved in several collaborative opportunities, including participating in:

- Performance modeling and the creation of benchmarking suites in collaboration with NSF, DOE, and NSA;
- Review of HPCMP Challenge Project proposals by non-DoD activities;
- Planning activities for the HPC User Forum and the Joint Army-Navy-NASA-Air Force (JANNAF) Propulsion Conference, which facilitates the exchange of technical information and coordination of research and development of missiles, guns, and space propulsion;

- The Grid Computing initiative, helping identify areas for joint collaboration, streamlining security requirements, and establishing standards;
- Homeland defense initiatives on critical IT infrastructure protection;
- The Hawaii Intranet Consortium, which seeks to share existing resources among DoD activities and other independent network initiatives to minimize costs; and
- The Next Generation Internet, Fednets, and Internet 2.

Using Program Evaluation

Summary of Performance Data

The Director periodically meets with the project managers to assess the program's status. In addition, the Joint Interoperability Test Command (JITC) provides independent assessment of the operational effectiveness and suitablity of the program. The Director, with the cooperation of the project managers, has developed both output and outcome metrics that measure the success of the modernization effort. Key output metrics are captured in an annual report published by the HPCMPO, the *HPC Systems Metrics Report*, which includes both usage and turnaround times on all HPCMP shared resource systems for all computational projects. Monthly use and turnaround time analysis is used to adjust operational policies and procedures to ensure that computational resources are being delivered to DoD's highest priority computational projects. In addition, monitoring usage of HPCMP systems ensures their efficient and effective use. When combined with requirements and allocation data, this information serves as an important input in determining the acquisition of future HPC resources.

Performance Results

The performance data discussed above is actually a subset of the overall metrics developed and monitored by the program. In particular, the DREN and CHSSI components actively monitor tailored metrics appropriate to their activities. This is discussed in detail in Section 2.

As noted in the program's *Systems Metrics Report*, data from FY 2002 shows that HPCMP usage continued to grow at a rate of almost 40% compared to FY 2001. DoD Challenge Projects continued to use resources at an increasing rate. These projects used almost all of their allocations for FY 2002. Usage of Service/Agency allocations increased significantly compared to FY 2001. Efforts to ensure a more efficient matching of requirements to resources should result in continuing increases into future years.

In addition to Challenge Project and standard Service/Agency workload, the HPCMP also supported several urgent and high-priority Service/Agency projects, including several related to re-construction of the Pentagon following the terrorist attack and anti-terrorist technology. Altogether, these high-priority and

urgent projects amounted to approximately 100,000 hours of computer time on various program resources and were delivered with minimal turnaround times.

Since the total workload on HPCMP systems increased, turnaround times on HPCMP systems grew somewhat during FY 2002. We expect a significant improvement of expansion factors in early FY 2003 as major new HPC capabilities are added.

CONSIDERING FUTURE TRENDS

Applying Lessons Learned

HPCMP management at the centers and at the HPCMPO routinely assess lessons learned to modify processes, to improve acquisition strategies, and to achieve the Program vision to "provide a pervasive culture…routinely use advanced computational environments to solve the most demanding problems". Benchmarking activities focusing on the performance of hardware helps guide our acquisition decisions, and we are currently analyzing key applications codes in a systematic fashion to guide users to the most advantageous computing environment. Periodic reviews of each of the Program's components lead to modifications in our business practices, such as the restructuring of the PET program to make it a program-wide resource.

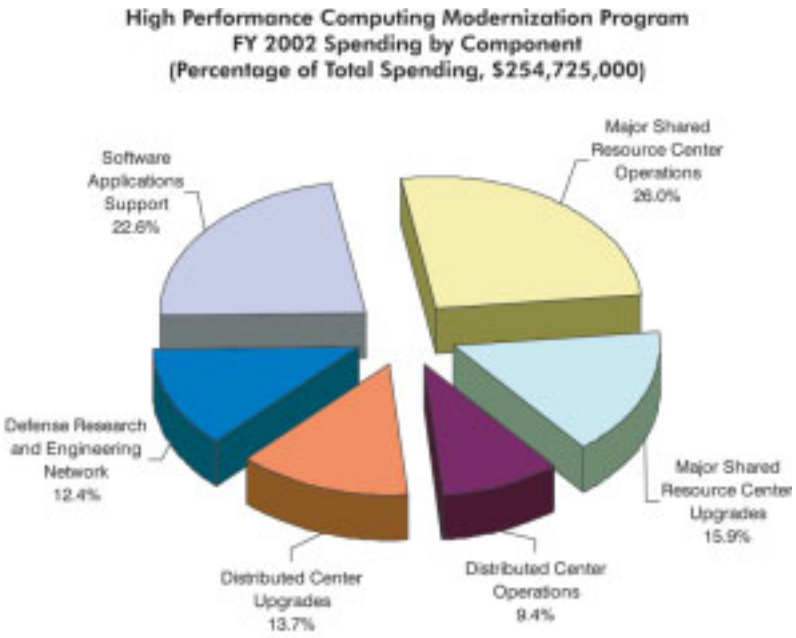
Looking Ahead

As the program enters its tenth year, the success of the initial effort promises a very strong future. With the continued support of the Congress and senior department leadership, the HPCMP community looks forward to continued improvement of the Department's supercomputing environment and the increasing sophistication of the user base. The DoD HPCMP community, working in concert with other Federal agencies to identify future trends and requirements, anticipates more extensive cooperation with those agencies. As a result of applying lessons learned, the HPCMPO is carefully considering restructuring a major component, the CHSSI, to encourage user involvement and enhance its relevance to the whole user base. The program will continue to use synthetic benchmark methods to improve overall understanding of our applications and model performance. These activities will

promote the efficient and effective use of supercomputing resources for national defense.

Financial Analysis

The HPCMP is a technology program and a major defense acquisition program (MDAP) (Acquisition Category ID) under the cognizance of the Deputy Under Secretary of Defense for Science and Technology. The program is included in the DoD e-business architecture within the operational, systems, and technical views. The program provides supercomputing services for DoD scientists and engineers using commercial standards and protocols.



The HPCMP Director is APDP Program Management level III certified. He uses integrated project teams to execute acquisition and deployment of high performance computing assets, provides overall guidance, and sets individual cost schedule and performance goals for each project manager. The Program Office monitors and evaluates the progress each element achieves toward meeting the program goals.

The HPCMP funds (1) capitalization, sustainment, and operations at the MSRCs; (2) annual capitalization for selected DCs; (3) wide area network services for the DoD HPC community; (4) development of key HPC software; and (5) expert HPC services from leading academic institutions.

The HPCMP has multiple contracting officers assigned in support of different efforts. The program office uses contracting officers at the GSA in support of HPC equipment and services purchases and uses contracting officers at various DoD installations in support of service contracts. This support is necessary because the program requires multiple contracts and contract types with an ongoing need to ensure that state-of-the-art technical capabilities are made available to DoD scientists and engineers in a timely manner. Contracts are a combination of firm fixed price, cost and/or indefinite delivery/ indefinite quantity. All procurement awards are made for commercially available systems. Acquisitions are accomplished competitively to the fullest extent possible and encourage the inclusion of small, disadvantaged businesses and Minority Serving Institutions (MSIs).

FY 2002 Budget Resources: HPCMP Appropriations

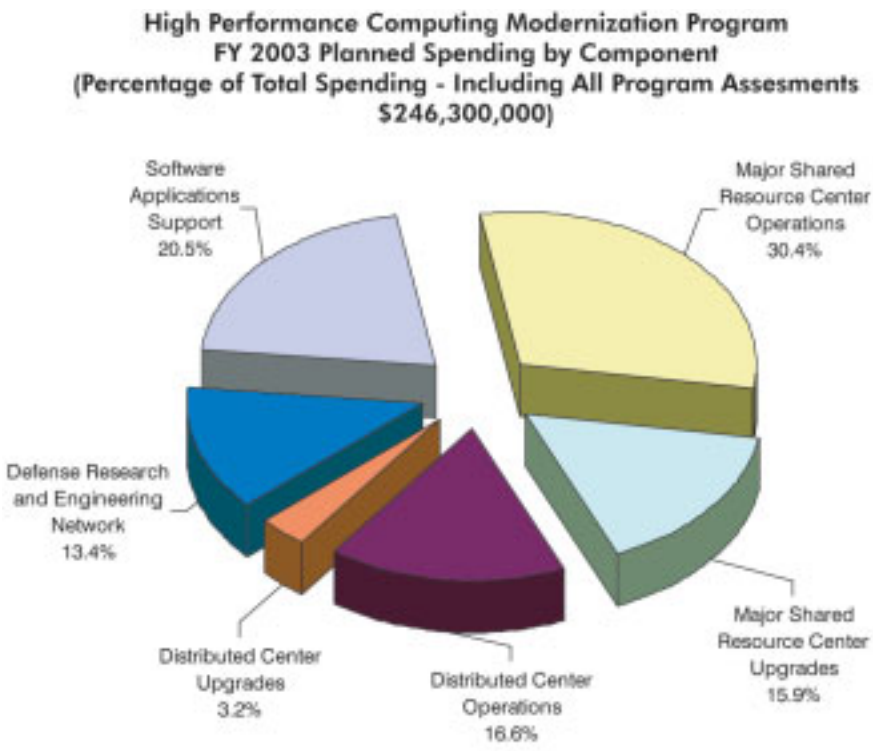
Obligations and Costs

The financial manager conducts semi-annual reviews with each major component manager and major field activity to review actual cost performance against budgeted cost goals in a tailored work breakdown structure format with special attention on variance analysis. Significant variances are reported to the Program Director and corrective actions taken. The Program receives approximately $250,000,000 each year in funding appropriated for the Department of Defense. Cash Flow during 2002 is illustrated by the following Cash Flow Statement.

High Performance Computing Modernization Program
Cash Flow Statement
October 1, 2001 - September 30, 2002

	Fiscal Year 2002
Revenue	
Research, Development and Engineering Funding	
President's Budget	$188,376,000
Congressional Funding	($4,852,000)
Department of Defense Reprogramming - In	$0
(Less Department of Defense Reprogramming - Out)	($4,110,000)
Net Research, Development and Engineering Funding	**$179,414,000**
Procurement Funding	
President's Budget	$50,763,000
Congressional Funding	$25,000,000
Department of Defense Reprogramming - In	$0
(Less Department of Defense Reprogramming - Out)	($452,000)
Net Procurement Funding	**$75,311,000**
Net Revenue	**$254,725,000**
Expense	
Major Shared Resource Center Operations	$66,463,215
Major Shared Resource Center Upgrades	$40,536,779
Distributed Center Operations	$23,908,600
Distributed Center Upgrades	$34,774,221
Defense Research and Engineering Network	$31,592,700
Software Initiatives	$57,449,486
Net Expense	**$254,725,000**
Balance (As of September 30, 2002)	$0

Since the program began in 1994, validated requirements have always exceeded the computing capability available to address those requirements. This occurs: 1) because the use of science based models and simulations to answer research questions and solve engineering problems has dramatically grown; and 2) because fully funding the HPC requirement is unaffordable given the entire scope of activities the DoD budget must address. While fiscal resources do not fully meet the computational requirements of the science and technology and test and evaluation communities, the returns' provided are substantial and are allocated to the highest priority projects. The program has consistently met approximately half of the validated requirements because of major cost performance improvements in computer technology since 1994. These shortfalls can be seen in the following 2002 Income Statement.



Financial Trends

In FY 2003 sustainment of capability and the continued modernization of HPC systems, storage, and scientific visualization capabilities will be greatly improved at the MSRCs through new technical services contracts. We plan to acquire or upgrade systems at three to five DCs. Network services provided under the American Telephone and Telegraph contract will fully transition to MCI WorldCom, Inc., providing substantially high services for essentially the same cost. Development of shared scalable applications supporting software will continue. The DoD HPC user community will be supported by PET efforts. The Software Protection Initiative will continue to mature. The following chart breaks out planned spending program-wide during 2003.

Finally, as stated earlier, the program requires multiple contracts and contract types. The charts on page 16 display spending by vendor in 2002 and planned spending by vendor in 2003. There is an anomaly in the Site Preparation, Infrastructure and Acquisitions in Negotiation category caused by continued negotiations affecting final award of the congressionally added

High Performance Computing Modernization Program
Income Statement
October 1, 2001 - September 30, 2002

	Fiscal Year 2002
Income	
Research, Development and Engineering Funding	
Major Shared Resource Center Operations	$66,463,215
Distributed Center Operations	$23,908,600
Defense Research and Engineering Network	$31,592,700
Software Initiatives	$57,449,486
Procurement Funding	
Major Shared Resource Center Upgrades	$40,536,779
Distributed Center Upgrades	$34,774,221
Defense Research and Engineering Network	$0
Software Initiatives	$0
Total Income	**$254,725,000**
Expense	
Research, Development and Engineering Funding	
Major Shared Resource Center Operations	$66,463,215
Distributed Center Operations	$23,908,600
Defense Research and Engineering Network	$31,592,700
Software Initiatives	$37,096,224
Depreciation of Capital Assets	
Hardware	$88,508,286
Software	$19,711,952
Total Expense	**$267,280,977**
Balance (As of September 30, 2002) (See Note 5)	-$12,555,977

Note 1: Expenses include travel; supplies; government and contractor salaries and training; maintenance of hardware and software; studies and analysis; annual operations investments; communications, utilities, facilities lease and facilities maintenance.

Note 2: Software initiatives are separated into 2 distinct categories - expenses associated with research and development, management, education/training and expert services; and capitol assets resulting from developed software.

Note 3: Depreciation for HPC hardware is calculated using a 42 month straight-line depreciation method. Current HPC technology development results in predictable obsolescence. Generally after 42 months of use, HPC systems are retired with little or no residual value. Fiscal year 2002 depreciation includes the 12 month value calculated for all systems in the inventory between October 1, 2001 through September 30, 2002.

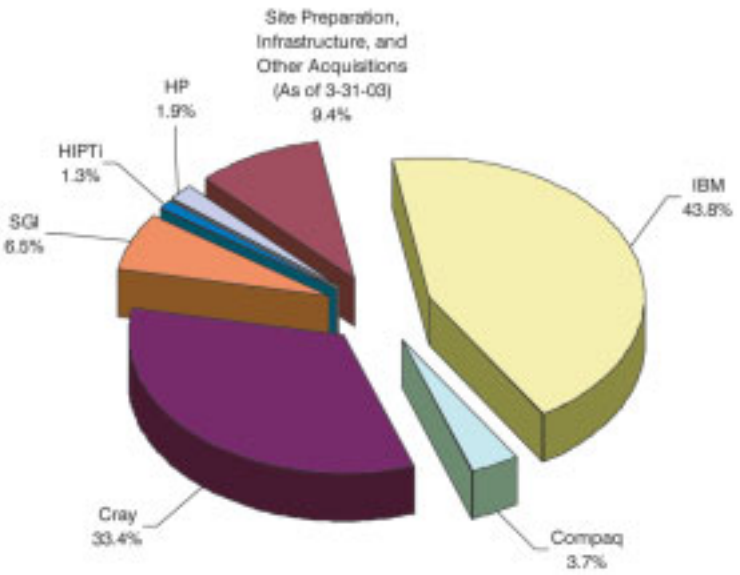
Note 4: Depreciation for HPC software is calculated using a 60 month straight-line depreciation method. A period of 60 months is used because it is the typical life cycle of HPC software before significant modifications are required. Fiscal year 2002 depreciation includes the 12 month value calculated for all software in the inventory between October 1, 2001 through September 30, 2002.

Note 5: Annual program investments in system hardware have not been made at levels sufficient to maintain stable equipment inventories. For several years depreciated values have not been offset by new assets.

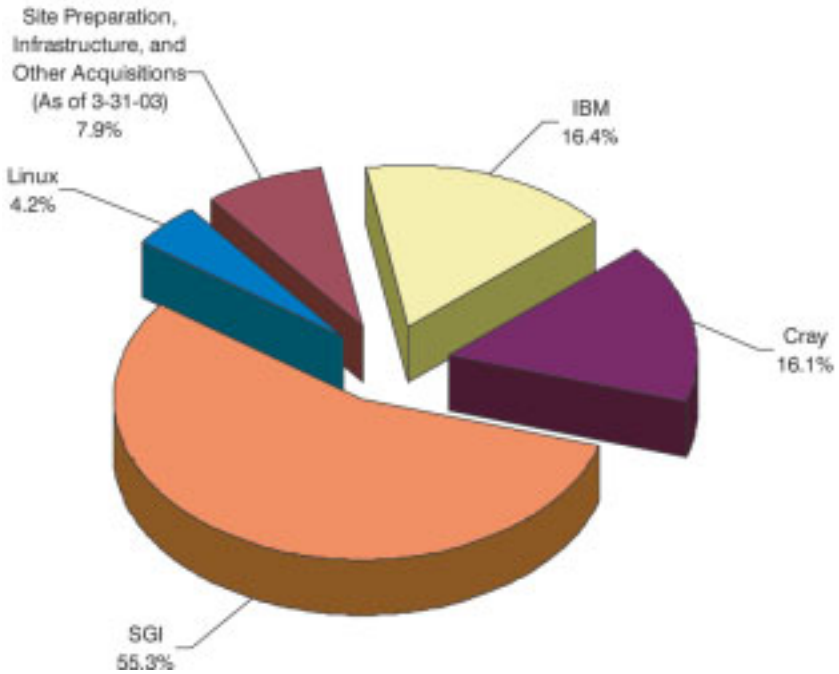
funding for the Army High Performance Computing Research Center (AHPCRC).

The program continues to deploy, sustain, and upgrade commercially available high performance computing environments and networking services in support of DoD laboratories and test facilities. The ensuing activities of the HPCMP have substantially improved the Department's computational capabilities with the objective of providing the DoD the technology to ensure dominance on the battlefield by the early fielding of the most advanced computing capability available.

High Performance Computing Modernization Program
FY 2002 Acquisitions by Vendor
(Percentage of Total Spending, $75,311,000)



High Performance Computing Modernization Program
FY 2003 Acquisitions by Vendor
(Percentage of Total Spending, $47,212,000)



Section 2

Performance Results

SECTION 2 — PERFORMANCE RESULTS

PROGRESS TOWARD STRATEGIC GOALS AND OBJECTIVES

FY 2002 PERFORMANCE

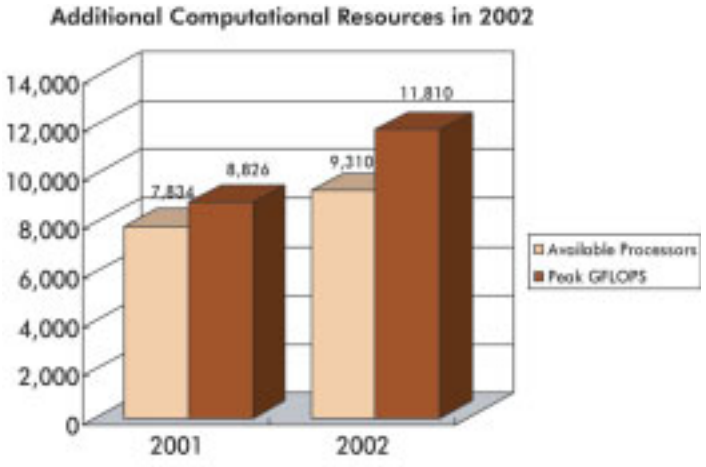
Goal 1: Provide the best commercially available high-end HPC capability

One of the major goals and activities of the HPC Modernization Program is to continually upgrade HPC capabilities at its four MSRCs. The technology insertion process (TI-XX, in which "XX" is the fiscal year) annually requests proposals for upgrades and new HPC systems from each HPC hardware vendor; evaluates their responses; and provides recommendations to senior management on which HPC systems to acquire for that particular year. The evaluation of responses to hardware proposals considers several major categories, including system usability, confidence in the proposing vendor, performance, and price.

Performance evaluation of HPC systems is based on a set of benchmark codes, which are in turn, firmly based on user requirements. These requirements determine the set of application benchmark codes and test cases, and these are re-evaluated each year. In addition to this set of application benchmark codes, the benchmark suite also contains a robust set of synthetic benchmarks, which are designed to independently test performance of HPC systems across several important system attributes, such as central processing unit performance,

memory performance, and input/output performance. These synthetic benchmarks provide information on how HPC systems are likely to perform on future applications, while the set of application benchmarks is designed to provide performance on current and projected HPCMP workload. Together they are used to create an overall performance score for each HPC system proposed for acquisition.

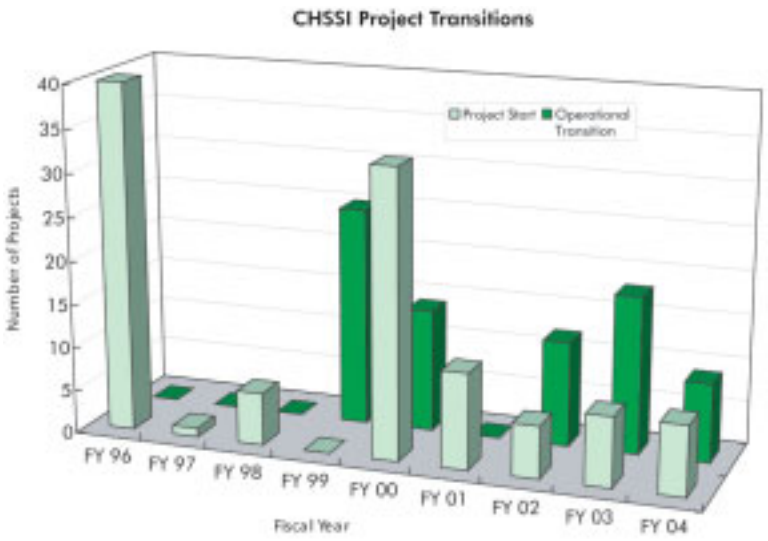
Performance and price/performance are considered as separate evaluation criteria; each is important in its own right. Overall price/performance is determined for a proposed set of HPC system acquisitions with the help of an optimization procedure which takes both price and performance into account on individual application test cases. This optimizer produces an overall price/performance score for each proposed set of alternative systems by shifting workload among proposed systems to maximize overall performance for a specified total acquisition cost. In addition, constraints are placed on the optimizer such that the overall application performance is spread among individual application test cases according to the desired percentage of total performance on these cases as determined by user requirements. This overall price/performance score for each proposed set of alternatives, in addition to the total performance score for the entire set, is one of the major criteria used to make final acquisition decisions. The strong dependence of these decisions on explicit user requirements, as reflected by the benchmark suite, ensures that new HPC capability will be used efficiently and effectively by our user base.



Since the average useful life of any given HPC system is approximately four years, we continually use our technology insertion process and emerging benchmarks as the basis for hardware acquisitions. During 2002 we funded three large Compaq HPC systems with a total of 1,504 processors and a 256 processor Origin HPC system from SGI. Through equipment consolidation, we also created the world's largest Cray T3E (1,888PE) at the Engineer Research and Development Center.

Goal 2: Acquire and develop joint-need HPC applications, software tools, and programming environments

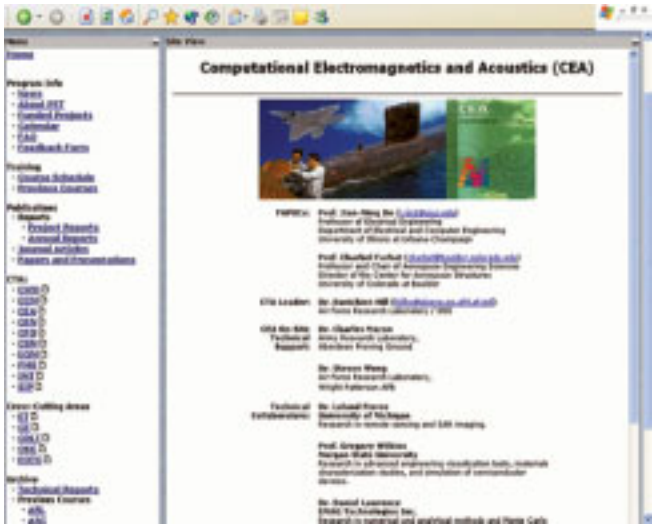
The Program is acquiring and developing joint-need HPC applications, software tools, and programming environments through the Software Applications Support (SAS) component. SAS consists of three facets: the Common High Performance Computing Software Support Initiative (CHSSI), the Programming Environment and Training (PET), and the Software Protection Initiative. CHSSI and PET enable HPCMP users to accomplish their work more efficiently. CHSSI participants redesign legacy software to run on new computer architectures. Software that is scalable, portable, and accurate helps the Department's scientists and engineers take full advantage of the new computer systems' significant capabilities. Through PET, the program's systems are made more user-friendly and users are afforded training and tools to be more productive.



CHSSI funds and oversees in-house development of militarily significant scientific and engineering codes. The CHSSI Project Manager acts as executive agent, ensuring high priority, technically feasible projects are selected and effectively managed to reduce risks inherent in such software development efforts. The HPCMPO solicits proposals annually from the Service and Agency science and technology and test and evaluation executives who submit their proposals prioritized for military relevance. Subject matter experts rate the proposals for technical merit and limited risk. The highest ranking proposals, which do not duplicate or overlap existing efforts, are selected subject to the availability of funds. Projects selected typically have short (three years or less) development periods; each project's funding averages $500,000 annually.

Goal 3: Educate and train DoD's scientists and engineers to effectively use advanced computational environments

The PET initiative enables the DoD high performance computing user community to make the best use of the computing capacity the HPCMP provides and to extend the range of DoD technical problems solved on HPC systems. PET is enhancing the total



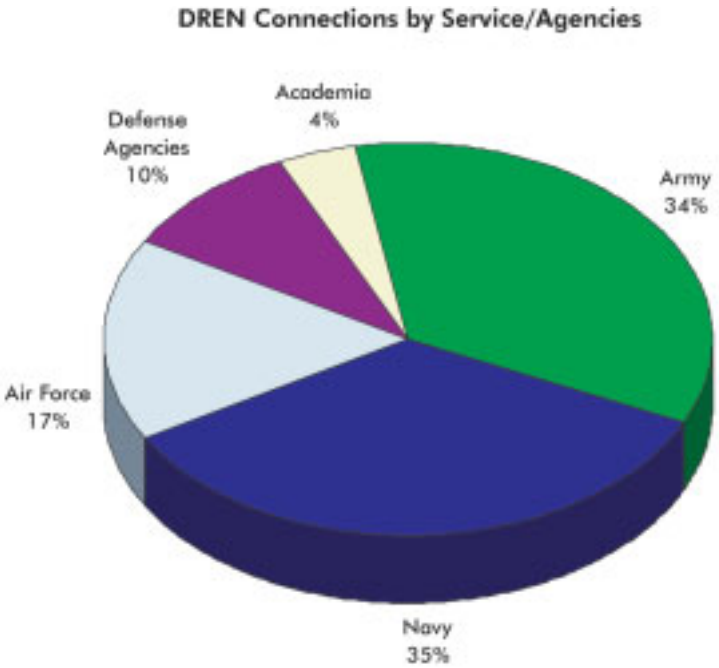
capability and productivity of the program's user community through training, collaboration, tool development, software development support, technology tracking, technology transfer, and outreach to users. PET is responsible for gathering and deploying the best ideas, algorithms, and software tools emerging from the national high performance-computing infrastructure into the DoD user community.

PET accomplishes its goals through three approaches:

- One-on-one software programming support to users
- Development and transfer of new computational technologies to DoD
- Formal and informal training

Goal 4: Link users and computers sites via high-capacity networks, facilitating user access and distributed computing environments

Since the DoD HPC community is widely dispersed, the program uses the Defense Research and Engineering Network (DREN) to link users to each other and to the HPC centers. High capacity network connectivity between sites and users is critical. Since its inception, DREN has evolved from a full mesh DS-3 network to an OC-48 based cloud supporting asynchronous transfer mode (ATM), internet protocol (IP), and MPLS services.



DREN provides these services to a variety of clientele throughout the Department.

Activities in 2002 were focused on positioning ourselves for the next 10 years. 2003 is the year that DREN is moving from an ATM backbone to MPLS (multi-protocol layer switching). In January 2003, we accepted delivery of a new high capacity network. Over the next year, we will transition all sites from the old DREN ATM backbone to this new DREN MPLS backbone.

The contract for services is an IDIQ firm-fixed-price vehicle with a 3-year base and 7 one-year options, with a ceiling of $450 million. This contract will provide both IP and ATM services over the core and will have jumbo frame capacity, IPv6, multi-cast, and a number of other

capabilities that will be important in the future. There are also provisions for light wave capabilities as soon as this new technology stabilizes.

Goal 5: Promote collaborative relationships among the DoD HPC community, the National HPC community and Minority Serving Institutions (MSIs) in network, computer, and computational science

Our resources and our community of users and stakeholders have continuously evolved since the program's inception. One component of the program has been our outreach activities. Outreach raises the Department's awareness of the support available through the program. It promotes the appropriate use of HPCMP resources within the DoD and provides a conduit for exchange of scientific and engineering technical information between and among the Services, Agencies, and other Federal agencies. Outreach also encourages our national infrastructure and youth to become more proficient in the high technology scientific and engineering disciplines needed to maintain US technical superiority. Outreach provides the stakeholders and taxpayers with a means of understanding what Congressional investment in HPC supports.

Equally important, Outreach activities give the HPC user community a means of providing feedback to the Program's managers and decision makers. Through site visits, new user

surveys, conferences, advisory groups, and independent assessments, the program benefits from the observations, recommendations, and criticisms it receives.

We promoted a vigorous outreach program in FY 2002. The High Performance Computing Modernization Program Office participated in twelve international, national, and regional conferences throughout the United States, including those sponsored by the Armed Forces Communications and Electronics Association, the National Defense Industrial Association, the American Institute of Aeronautics and Astronautics, and the Institute of Electrical and Electronic Engineers. Individual centers were routine participants in similar conferences and symposia, raising the awareness of the Department, its academic and industrial partners, and its allies to the potential of high performance computing.

Each center has an ongoing outreach program that addresses the needs of their community and potential customers. As a Program, our centers have reached out to Service Academies and institutions of higher learning to familiarize more of our nation's future leaders with the potential of high performance computing. Several cadets participate in internship programs at our centers, including Maui and Alaska. Similarly, the Army's AHPCRC in Minneapolis, MN, runs a summer internship program, allowing students from Minority Serving Institutions an opportunity to gain hands on experience with HPCMP resources and methodologies. Annually, students attend the intensive program, which emphasizes the use of simulation and modeling, parallel computing, and graphics and visualization to solve real world problems of interest to the Army. The Institute's purpose is not only to train students in these areas but also to encourage them, especially women and minorities, to pursue graduate studies or careers and HPC."[1]

[1] AHPCRC web site http://www.arc.umn.edu/education/summer-inst.html

Section 3

Management Accomplishments and Challenges

Section 3 — Management Accomplishments and Challenges

Accomplishments

Contract Awards

The following contracts were awarded by our organization in 2002:

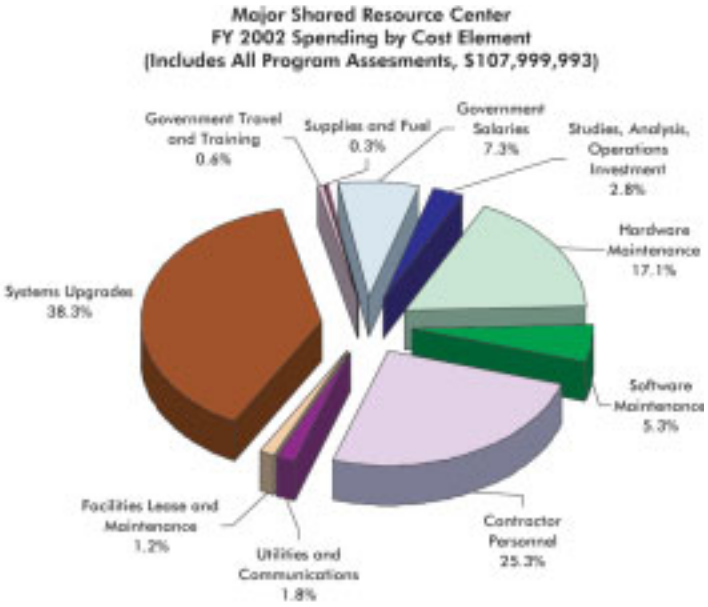
Contract	Target (Millons)	Ceiling (Millons)
HPC Design: Instrumental, Inc., Bloomington, MN GS04T02DEA0030, FFP and T&M Award: October 31, 2002	$53.3	$53.3
DREN: WorldCom Gov't Mkts, McLean, VA DCA200-02-R-5008, IDIQ FFP Award: April 4, 2002 Definitized: June 6, 2002	$200.0	$275.0
ARSC Support Services: University of Alasksa, Anchorage, AK IDIQ Task Order, Cost Reimbursable Award: October 14, 2002 Definitized: October 14, 2002	$49.5	$49.5

In addition, we worked towards award of the following contracts in early 2003:

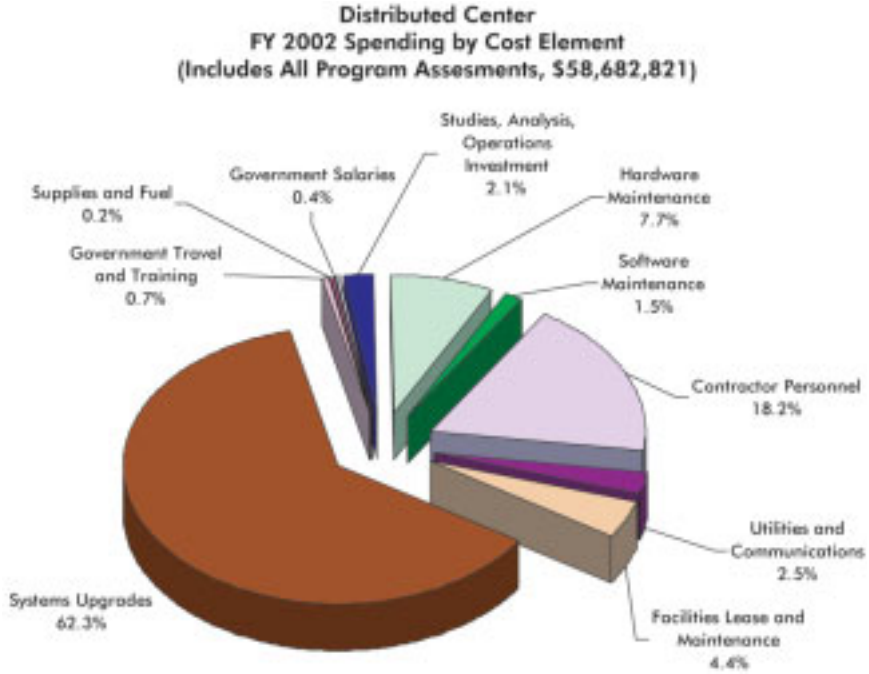
Contract	Target (Millons)	Ceiling (Millons)
ARL MSRC Support Services: Raytheon, Aberdeen, MD GSA FTS Mill GWA, CPFF Award: January 31, 2003	$90.0	$90.0
ASC MSRC Support Services: Computer Sciences Corp., Wright-Patterson AFB, OH GSA FTS Mill GWA, CPFF Award: January 31, 2003	$52.2	$52.2
GSA: Multiple Awards, Multiple Award: January 15, 2003	$46.9	$46.9

HPC Centers

During 2002, we were able to significantly increase the computational capabilities at the four Major Shared Resource Centers (MSRC) by nearly 48%. In actual values, the MSRCs added additional systems that provide 4.8 trillion floating-point operations during the year. Also during 2002, the HPCMP conducted a new procurement for the four follow-on integration contracts at the MSRCs. The awards are to be announced in 2003.



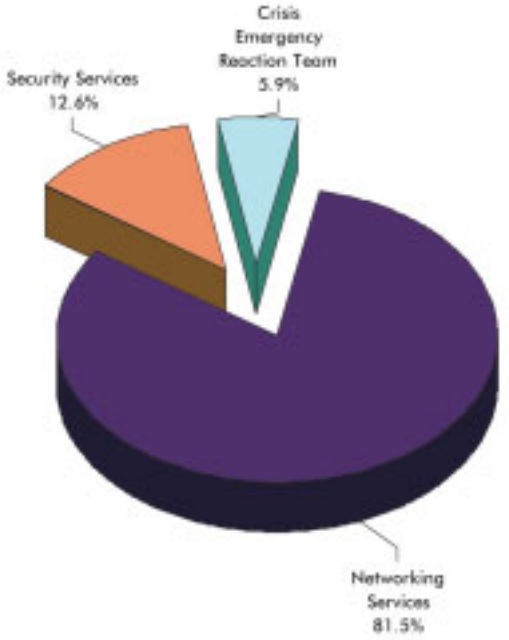
FY 2002 saw the implementation of new policies concerning the Distributed Centers. Recognizing that distributed centers had historically been awarded equipment to meet the needs of a specific project or mission need, we reviewed the existing centers to determine if that need had been successfully addressed. Where feasible, centers that had satisfied their schedule, cost, and requirements goals were released from their formal association with the program, thus lessening their reporting and oversight burden. By September 2002, nine centers had made the transition. The remaining centers were categorized to reflect their actual relationship to the program – as "allocated" or "dedicated" distributed centers. In both cases, the allocated and dedicated distributed centers continue to receive HPC resources funded through the HPCMP.



Networking and Security

In April 2002, we awarded a Firm Fixed-Price (FFP), Indefinite Delivery/Indefinite Quantity (IDIQ) contract to MCI WorldCom Communications, Inc. The contract is a follow-on contract to the DREN Intersite Services Contract (DISC) and provides state-of-the-art WAN services to support our program and DoD users in various technical communities. As part of the process of transitioning this contract to MCI, a comprehensive implementation and transition plan was completed in July 2002. A Comprehensive Security Assessment (CSA) was completed on the new network in December 2002. As a result of this assessment, the Designated Approving Authority granted MCI WorldCom an interim authority to operate in January 2003. After the CSA, Initial Performance Capability (IPC) tests were completed on the new backbone. The IPC tests required the new carrier to set up 10 Service Delivery Points (SDPs) and then prove that those SDPs and the network backbone met the requirements for availability, latency, and throughput. The tests were successful and the backbone was accepted for service in January 2003.

Defense Research and Engineering Network
FY 2002 Spending by Major Sub-element
(Includes All Program Assesments, $31,592,700)



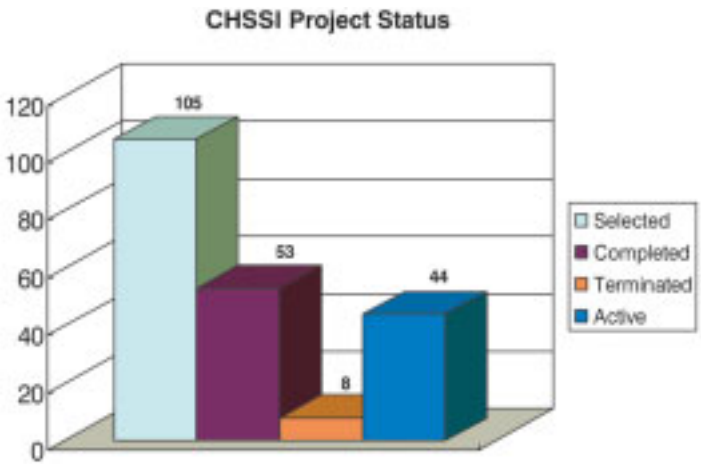
As a result of switching to the new backbone, OC-12 gateways for IP and ATM traffic were activated in Los Angeles, California, and Washington, DC in December 2002. This allowed the exchange of network traffic between the old DREN backbone and the new DREN backbone.

A technology insertion for a one box solution at SDPs with nine DREN core nodes was completed and approved in September 2002. The single IP/MPLS box allows the integration of ATM and IP traffic to be sent across a single connection to their core. This approach maximizes the use of MPLS label switch pads to provide virtual networks for the segregation of DREN traffic.

A new port mirroring technique was engineered that allows a single intrusion detection device to monitor multiple paths and interfaces at internet access points. Peering services between NIPRNET and DREN have been upgraded to a 100Mbps connection.

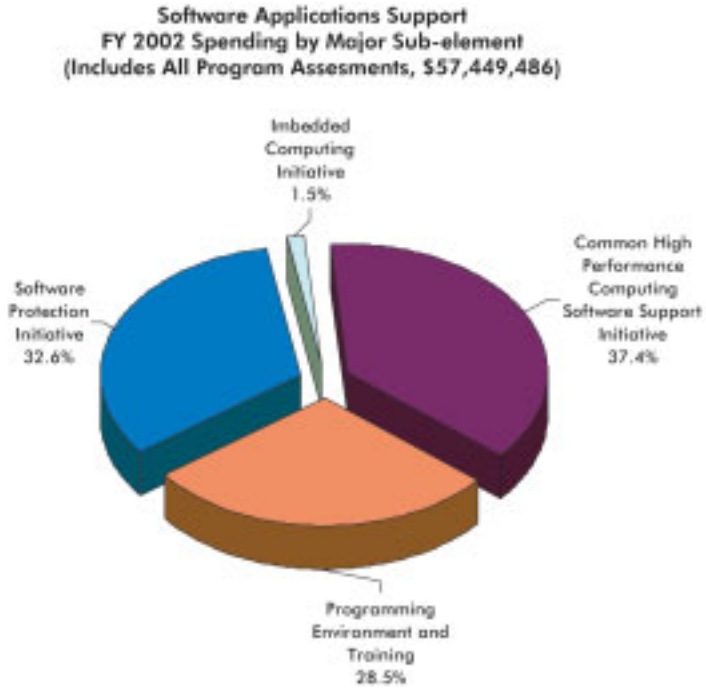
Software Applications Support

In FY 2002, eight new projects were selected from thirty-six proposals submitted by the Services and Agencies. These new projects will begin development in FY 2003 and are expected to provide the DoD scientific and engineering communities with critical software to support chemical and biological defense (identification, transport, and containment), electronic battlefield environment planning and simulations, and the design of new materials.



From CHSSI's inception to the end of FY 2002, 51 scientific and engineering code development efforts were completed. In FY 2002 alone, CHSSI project leaders completed 12 projects and released 19 codes to the user community.

CHSSI's return on investment is the capability of our scientists and engineers to effectively tackle more and more complex problems and deliver technological solutions demanded to support today's military. This annual report will focus on one facet of CHSSI's contributions to the DoD - modeling and simulation. CHSSI codes have helped improve the speed, complexity and accuracy of military simulations - materials, space and earth weather, littoral environments, weapons systems, and simulations for the battlefield. CHSSI codes allow engineers to model and test weapons stores and how they separate from aircraft before the stores are tested in actual flight. CHSSI codes provide accurate models of blast effects and contaminant transport. Codes released in FY 2002 will be used for space-weather forecasting and nowcasting; modeling radar-based sensing of surface and subsurface targets, including land mines, unexploded ordnance, and vehicles; modeling of 3-D rectangular arrangements such as the pulsed plasma micro-thruster for microsatellite propulsion; modeling and simulating large-scale military communications and tactical signal intelligence platforms; weather forecasting model improvements; and simulating large scale, heterogeneous, communication networks.



PET's focus was placed on the ten HPCMP computational technology areas (CTA) and five PET cross-cutting areas (Computational

Environment, Enabling Technologies, Collaborative Distance Learning Technologies, Online Knowledge Center, and Education, Outreach, and Training Coordination) with a broad HPCMP-wide management approach.

During FY 2002, PET supported 52 training events (including several workshops and seminars), with an average attendance of 15 students. Evaluations of formal classes in the latter portion of FY 2002 averaged scores of approximately 4.4 on a scale of 0 to 5. It is anticipated that FY 2003 will see a marked increase in the number of such events, as 30 classes are planned for the first quarter. These events, as well as the many thousands of hours of one-on-one user programming support, were provided by leading scientists drawn from many of our leading universities.

PET has also provided significant outreach to, and training of, students and faculty at MSIs, including summer institutes, summer intern programs, and faculty/ graduate student participation in PET development projects. During FY 2002, ten MSIs participated in PET.

Also in FY 2002, PET supported 40 high performance computing software and algorithm development projects, mostly university-based, encompassing the 10 CTAs and 4 of the 5 cross-cutting areas, representing a value of approximately $4.5M, with the intent of transferring the best available applicable high performance computing software technologies to the DoD. Among these projects was the development and deployment of a HPCMP-wide On-line Knowledge Center (OKC). The OKC provides information on all aspects of PET, including delivered reports, sources of user help, a training calendar, and class registration. While still in the process of being populated with PET information, the OKC will be the source of all PET information in the future.

One of the major challenges of DoD using, to the fullest extent possible, modern high performance computing platforms is the development of complex physics-based software that can make use of tens to thousands of commodity processors to achieve the performance that these platforms provide and DoD requires. PET is facing this challenge with a robust, multi-faceted program, making use of the best intellectual talent available.

PROGRAM OVERSIGHT

In May 2002, the HPCMP was designated a major defense acquisition program (MDAP) under the oversight cognizance of the OUSD(AT&L). With this designation came the requirement for submitting the Consolidated Acquisition Reporting System (CARS) documentation, which the HPCMPO has complied with. During the previous eight years of its existence, the DoD HPCMP was designated a major automated information system (MAIS) program under the oversight cognizance of the Assistant Secretary of Defense (Command, Control, and Computers). The HPCMP has successfully met all documentation preparation requirements and passed all major milestone decisions (Milestone 0–Post Milestone II) required under the Office of the Secretary of Defense oversight. In addition, the HPCMP has submitted the required Clinger-Cohen Act (CCA) documentation to support a program certification in FY 2003. The Director, Operational Test and Evaluation has continuously provided input and oversight to the HPCMP test processes and execution as well as administer and analyze user satisfaction with the HPCMP resources. The JITC has found that the HPCMP *"remains Effective & Suitable for its charter to 'provide High Performance Computing to the DoD S&T and T&E communities'"*.[2]

[2] HPCMPO/JITC 2002 Test Activities Outbrief, JITC HPC Test Team, Sept. 2002

Section 4

Financial Statement

SECTION 4 — FY 2002 ANNUAL FINANCIAL STATEMENTS

The HPCMP evaluates the effectiveness of each program component by measuring actual cost and schedule performance versus planned cost and schedule performance and through the measurement of actual outcomes verses planned outcomes. The MSRC contractors submit several reports regularly including a monthly and quarterly cost performance report (CPR) and quarterly contract funds status report (CFSR). Each contract specifies, as a deliverable, a work breakdown structure (WBS) to facilitate the on-going review of smaller task components. Cost/ schedule status reports are one of the primary tools used for oversight management of the MSRCs.

The HPCMP has provided a significant supercomputing capability to the Department of Defense scientific community. The balance sheets on the next two pages show the cumulative value of the program.

High Performance Computing Modernization Program
Balance Sheet
As of March 31, 2003

Assets and Equity

Hardware	$882,616,000	
Less: Depreciation		
Fiscal Year 1994-1999	$582,372,505	
Fiscal Year 2000:	$68,125,714	
Fiscal Year 2001:	$34,036,286	
Fiscal Year 2002:	$10,758,714	
Fiscal Year 2003:	$0	$187,322,781
Software (1)	$117,029,993	
Less: Depreciation		
Fiscal Year 1994-1997:	$45,801,067	
Fiscal Year 1998:	$17,789,985	
Fiscal Year 1999:	$15,667,400	
Fiscal Year 2000:	$9,509,220	
Fiscal Year 2001:	$5,222,404	
Fiscal Year 2002:	$2,035,326	
Fiscal Year 2003:	$0	$21,004,591
Manpower Contracts (2 & 3) Software Development		
Exercised Contract Value	$20,540,146	
Less: Value Consumed	$18,141,285	
Remaining Exercised Value		$2,398,861
Maintenance Contract (2 & 3)		
Hardware Maintenance		
Fiscal Year 2003:	$26,037,825	
Less: Value Consumed Hardware Maintenance		
Fiscal Year 2003:	$22,225,871	
Software Maintenance		
Fiscal Year 2003:	$10,000,169	
Less: Value Consumed Software Maintenance		
Fiscal Year 2003:	$8,406,697	$5,405,425
Intellectual/Operations		
Government Labor		
Fiscal Year 2003:	$18,023,028	
Less: Value Consumed Government Labor		
Fiscal Year 2003	$16,227,846	
Contract Labor		
Fiscal Year 2003:	$78,947,917	
Less: Value Consumed Contract Labor		
Fiscal Year 2003:	$68,534,770	$12,208,328
Total Assets and Equity		**$228,339,986**

Liabilities

Uncompleted Software Development	$2,398,861	
Maintenance Contract Liabilities March 31, 2003		
Hardware		
Fiscal Year 2003:	$3,811,953	
Software		
Fiscal Year 2003:	$1,593,472	
Intellectual/Facilities Expenses March 31, 2003		
Government Labor		
Fiscal Year 2003:	$1,795,181	
Contract Labor		
Fiscal Year 2003:	$10,413,147	
Total Liabilities	**$20,012,614**	
Total Program Equity		**$208,327,372**
Total Liability and Program Equity		**$228,339,986**

(1) Research, Development and Engineering Funding used to develop inventory software.

(2) Office of Management and Budget Circular A-11, Section 300 - Planning, Budgeting, Acquisition, and Management of Capital Assets, (Paragraph 300.4), defines capital assets as land, structures, equipment, intellectual property (e.g., software), and information technolgy (including IT service contracts) that are used by the Federal government and have an estimated useful life of two years or more. Therefore, manpower is treated as a capital asset.

(3) Small consumable items such as computer tapes and supplies are considered as expense items and not carried as inventory items.

High Performance Computing Modernization Program
Cash Flow Statement
October 1, 2001 - September 30, 2002

	Fiscal Year 2002
Revenue	
Research, Development and Engineering Funding	
President's Budget	$188,376,000
Congressional Funding	($4,852,000)
Department of Defense Reprogramming - In	$0
(Less Department of Defense Reprogramming - Out)	($4,110,000)
Net Research, Development and Engineering Funding	**$179,414,000**
Procurement Funding	
President's Budget	$50,763,000
Congressional Funding	$25,000,000
Department of Defense Reprogramming - In	$0
(Less Department of Defense Reprogramming - Out)	($452,000)
Net Procurement Funding	**$75,311,000**
Net Revenue	**$254,725,000**
Expense	
Major Shared Resource Center Operations	$66,463,215
Major Shared Resource Center Upgrades	$40,536,779
Distributed Center Operations	$23,908,600
Distributed Center Upgrades	$34,774,221
Defense Research and Engineering Network	$31,592,700
Software Initiatives	$57,449,486
Net Expense	**$254,725,000**
Balance (As of September 30, 2002)	$0

High Performance Computing Modernization Program
Income Statement
October 1, 2001 - September 30, 2002

	Fiscal Year 2002
Income	
Research, Development and Engineering Funding	
Major Shared Resource Center Operations	$66,463,215
Distributed Center Operations	$23,908,600
Defense Research and Engineering Network	$31,592,700
Software Initiatives	$57,449,486
Procurement Funding	
Major Shared Resource Center Upgrades	$40,536,779
Distributed Center Upgrades	$34,774,221
Defense Research and Engineering Network	$0
Software Initiatives	$0
Total Income	**$254,725,000**
Expense	
Research, Development and Engineering Funding	
Major Shared Resource Center Operations	$66,463,215
Distributed Center Operations	$23,908,600
Defense Research and Engineering Network	$31,592,700
Software Initiatives	$37,096,224
Depreciation of Capital Assets	
Hardware	$88,508,286
Software	$19,711,952
Total Expense	**$267,280,977**
Balance (As of September 30, 2002) (See Note 5)	-$12,555,977

Note 1: Expenses include travel; supplies; government and contractor salaries and training; maintenance of hardware and software; studies and analysis; annual operations investments; communications, utilities, facilities lease and facilities maintenance.

Note 2: Software initiatives are separated into 2 distinct categories - expenses associated with research and development, management, education/training and expert services; and capitol assets resulting from developed software.

Note 3: Depreciation for HPC hardware is calculated using a 42 month straight-line depreciation method. Current HPC technology development results in predictable obsolescence. Generally after 42 months of use, HPC systems are retired with little or no residual value. Fiscal year 2002 depreciation includes the 12 month value calculated for all systems in the inventory between October 1, 2001 through September 30, 2002.

Note 4: Depreciation for HPC software is calculated using a 60 month straight-line depreciation method. A period of 60 months is used because it is the typical life cycle of HPC software before significant modifications are required. Fiscal year 2002 depreciation includes the 12 month value calculated for all software in the inventory between October 1, 2001 through September 30, 2002.

Note 5: Annual program investments in system hardware have not been made at levels sufficient to maintain stable equipment inventories. For several years depreciated values have not been offset by new assets.

Section 5

Appendicies

SECTION 5 — APPENDICIES

APPENDIX A – PROGRAM EVALUATIONS

The Joint Interoperability Test Command (JITC), as the independent test agency, has responsibility for performing the oversight for the HPCMP test and evaluation activities. The test requirements include system acceptance testing at the MSRCs and Allocated DCs, System Acceptance Tests and full operational capability assessment for the Dedicated DCs, and software testing for the software initiative.

To support the ongoing operational assessment of the program, the JITC team reviews test plans, witnesses test activities, reviews site's test reports, and writes the independent test report for the activity. They also administer the HPCMP User Satisfaction Survey and conduct user interviews. The team collects information from each center, its users, and in many cases, the Service/Agency Approval Authorities in order to fulfill this requirement.

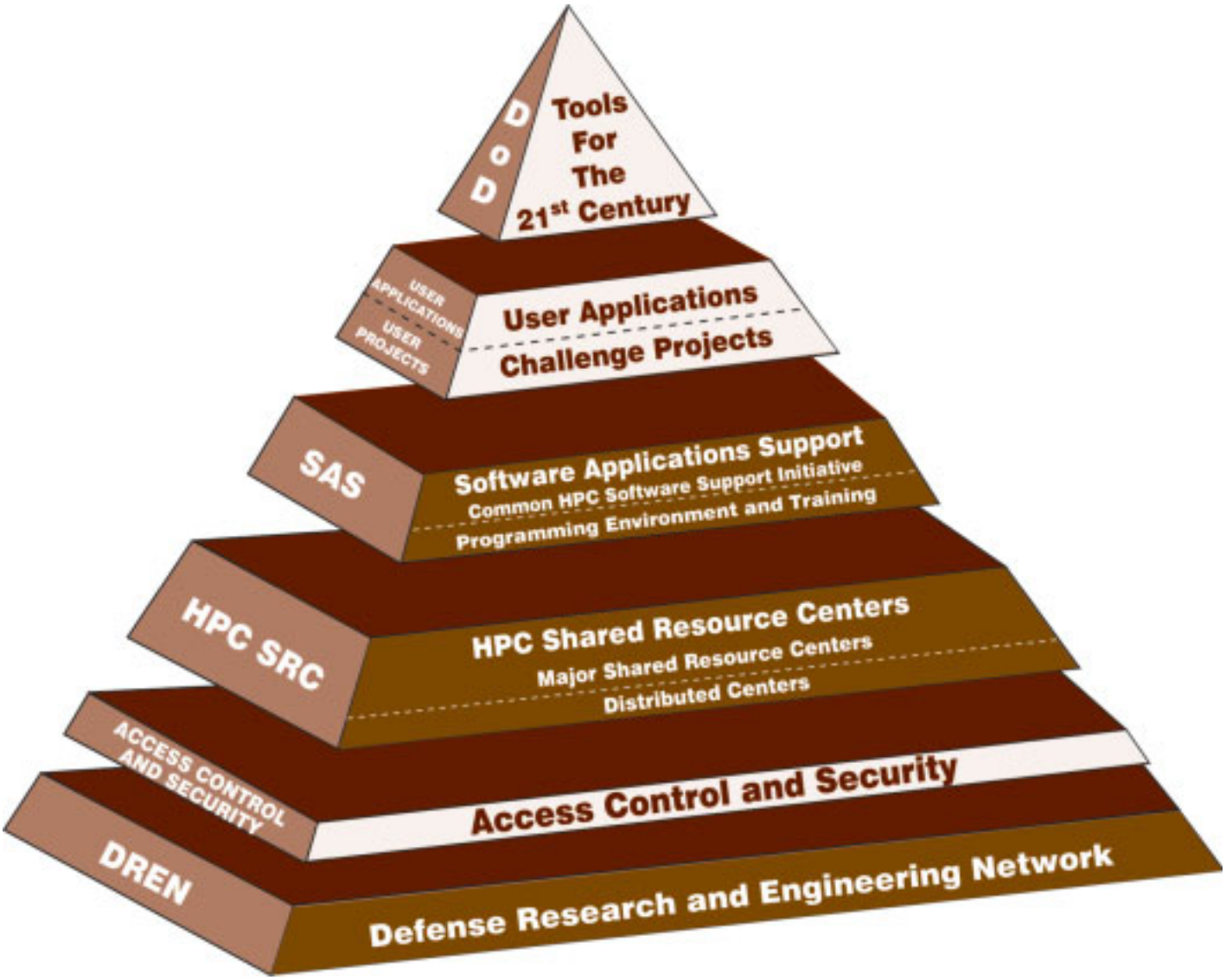
Performance Evaluation Assessment Review

In addition to the testing activities, each Distributed Center that receives new funding is required to undergo a Performance Evaluation Assessment Review. These reviews are part of the required HPCMP review process to evaluate HPCMP information technology (IT) investments under the Government Performance Results Act and Clinger-Cohen Act. These reviews were established in 2002 and superceded the previous Post-Deployment Evaluation and Assessment Process.

The first set of these reviews was held on June 11, 2002, as part of the HPCMP Users Group Conference (UGC) for sites that received funding in FY 2000–2001 and FY 2002. A representative of a major project which served as the justification for funding each DC was required to give a technical presentation showing how the DC was used to satisfy the project's computational requirements. The DC HPCMP Technical Evaluation Panel evaluated the presentation to determine whether the DC enabled the project to meet the goals which had been proposed for the DC.

FY 2002 awarded centers were required to give a milestone chart as part of the technical presentation to show where the site/ project was in the acquisition process (i.e., funding received, obligation of funds, acquisition, installation, etc.).

APPENDIX B – HPCMP INTEGRATED PROGRAM STRATEGY



Appendix C – Acronyms and Abbreviations

2-D	two-dimensions (dimensional)
3-D	three-dimensions (dimensional)
AHPCRC	Army High Performance Computing Research Center
APDP	Acquisition Professional Development Program
ATM	asynchronous transfer mode
CFSR	contract funds status report
CHSSI	Common High Performance Computing Software Support Initiative
CIO	Chief Information Officer
CPR	cost performance report
CSA	Comprehensive Security Assessment
CTA	Computational Technology Area
DC	Distributed Center
DISC	DREN Intersite Services Contract
DoD	Department of Defense
DOE	Department of Energy
DREN	Defense Research and Engineering Network
FFP	Firm Fixed-Price
FOC	full operational capability
FY	fiscal year
GSA	General Services Administration
HPC	high performance computing or high performance computer
HPCMP	High Performance Computing Modernization Program
HPCMPO	High Performance Computing Modernization Program Office
I2	Internet 2
IDIQ	Indefinite Delivery/Indefinite Quantity
I/O	input/output
IP	Internet protocol
IPC	Initial Performance Capability
IT	information technology
JANNAF	Joint Army-NASA-Air Force
JITC	Joint Interoperability Test Command
Mbps	million bits per second
MDAP	major defense acquisition program
MPI	Message Passing Interface
MPLS	multi-protocol layer switching

MSI	Minority Serving Institutions
MSRC	Major Shared Resource Center
NSA	National Security Agency
NSF	National Science Foundation
O-IPT	overarching-integrated product team
OKC	On-line Knowledge Center
OSD	Office of the Secretary of Defense
PET	Programming Environment and Training
SAS	Software Applications Support
SDPs	service delivery points
TI-01	Technology Insertion-01
TI-02	Technology Insertion-02
UAG	User Advocacy Group
US	United States
WAN	wide area network
WBS	work breakdown structure

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